Unit 18

ATOMIC AND NUCLEAR PHYSICS

Q. What do you know about atomic structure? Differentiate between atomic number and atomic mass number.

Ans. **Atomic Structure:**

Atom is the smallest particle of an element. It consists of two parts, central part is called nucleus which consists of protons, (carrying positive charge) and neutrons, (carrying no charge). So, we say that nucleus carries a positive charge. Outer part consists of electrons which are negatively charged particles and revolve around the nucleus in their orbits. Atom, as a whole, is a neutral particle because the number of protons and the number of electrons are equal in an atom.

The mass of proton and neutron is nearly the same i.e. 1.67×10^{-27} kg. As protons and neutrons exist inside the nucleus, so these are called nucleons. A nucleon is nearly 1836 times heavier than an electron. So the whole mass of an atom is concentrated in the nucleus.

Atomic Number:

The number of protons in a nucleus of an atom is called atomic number and is represented by the letter Z.

Atomic Mass Number:

The total number of protons and neutrons in a nucleus of an atom is known as atomic mass number and is denoted by the letter A.

Similarly the number of neutrons present in the nucleus of an atom is represented by N.

Nuclide:

If atomic number of an atom is Z and its mass number is A, then this atom is represented by the symbol $^{A}_{Z}X$ which is called a nuclide. e.g. there is only one proton in the nucleus of hydrogen atom so its atomic number is 1 and its mass number is also 1. So, it is denoted by $^{1}_{1}H$, which is called nuclide.

Isotopes:

Atoms of an element having same atomic number but different mass number are called isotopes.

Isotopes have same chemical properties due to same atomic number but different physical properties due to different mass number e.g. hydrogen has three isotopes, called protium, deuterium and tritium having nuclide $^{1}_{1}H$, $^{2}_{1}H$, and $^{3}_{1}H$, respectively.

Q. What is natural radioactivity? Explain it. Also describe the experiment performed by Rutherford.

Ans. Natural Radioactivity:

In 1896, a French scientist, Henry Becquerel, discovered radioactivity while performing experiments with compound of uranium.

In those days, there was no sunlight due to cloudy weather. So, he kept this compound in a paper and placed it in a drawer where already photographic plates were present. After a few days he observed the impressions on the photographic plates. He concluded from this fact that fogging of photographic plates were caused by the radiations emitted from uranium compound. In order to test his conclusion, he conducted many experiments.

He took a closed box into which no light could enter and placed in it the uranium salt and photographic plates near to each other and also separated them by their aluminium sheets. In both cases, he observed the same results. This showed that strong radiations are emitted by the uranium salt and they are not affected by the absence or presence of the sunlight. It does not matter even which compound of uranium is used. Whether this compound is in the solid or in the liquid state. Afterwards, with the discovery of thorium, polonium and radium etc., and the same actions found in these elements, the phenomena was termed as radioactivity.

Natural Radioactivity:

"A process in which the elements with the charge number or atomic number greater than 82 (i.e. Z>82), naturally keep on radiating, is termed as natural radioactivity."

Radioactive Rays:

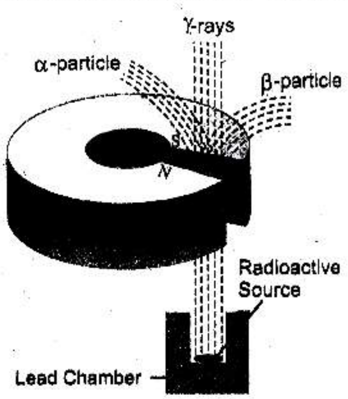
"The radiations which are emitted by the radioactive substances are called radioactive rays."

Since this is the natural property of elements so it is called natural radioactivity and these elements are called radioactive substance.

Now-a-days by using modern techniques, the elements which are not radioactive are made more radioactive. Such elements are called artificial radioactive elements. The process of radioactivity is spontaneous and continues for long period and is irreversible. Due to emission of radiation atoms of radioactive elements change into atoms of the other element.

Radioactive Isotopes:

"The atoms of radioactive elements whose atomic numbers are the same but have different atomic mass numbers are called radioactive isotopes."



Radiations emitted by radioactive elements are of three types. In order to study the nature of these rays. Rutherford and other scientists performed an experiment described below.

Experiment:

A small quantity of the radioactive source such as Radium was placed in a hole dug in block of lead. At a little distance, a photographic plate was placed so that the radiations fall on this plate. All this was placed in a lead chamber evacuated by

vacuum pumps so that radiation may not absorb air. A permanent magnetic field was applied on this chamber perpendicular to the plane of paper and directed inwards.

After some time, when the photographic plate was developed, it carried black spots at three different points which shows that these radiations are of three types.

1. Alpha (α) rays:

Rays which bend towards left due to the arc of large circle are α rays. These are positively charged particles.

2. Beta (β) rays:

Rays which bend towards right due to the arc of small circle are called β rays. These are negatively charged particles.

3. Gamma (γ) Rays:

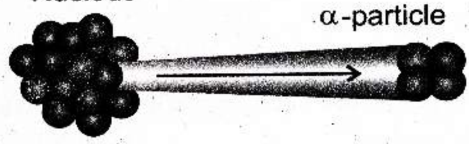
Rays which do not bend towards any side and pass straight making the spot in the middle of photographic plate are γ rays. They carry no charge.

Q. Write down the properties of radiations.

Ans. **Properties of Alpha (α), Beta (β) and Gamma (γ) rays**

Alpha (α) rays:

1. The α rays are emitted by radioactive elements. Their speed ranges between 1.4×10^7 to $1.8 \times 10^7\ ms^{-1}$. The speed of these rays depends upon the radioactive element from which these are emitted. Their speed is different for different elements, but the speed of all the α rays emitted by one element is the same.
2. α rays ionize the gas through which they pass.
3. α rays affect the photographic plates.
4. They produce fluorescence in Zinc sulphide.
5. At atmospheric pressure they travel a small distance in air. This distance is different for α rays emitted by different elements. For example the range for α rays emitted by Uranium is 2.7 cm while is 8.62 cm for α rays emitted by Thorium.

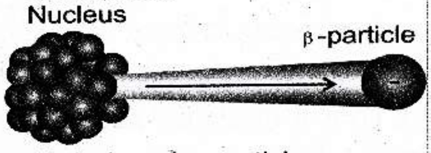


Emission of α-particle from the Nucleus

6. The electric and magnetic fields affect the α rays which shows that these are charged particles.
7. α rays consists of such positively charged particles, the mass of which is 4 times that of Hydrogen atom and they carry a charge twice that of a proton i.e. the α particles are in fact the nuclei of Helium.

Beta (β) rays:

1. β rays are emitted by the radioactive elements with great speed. Their speed ranges from one percent to 99% that of speed of light. The speed of all the β rays emitted by one element is not the same.

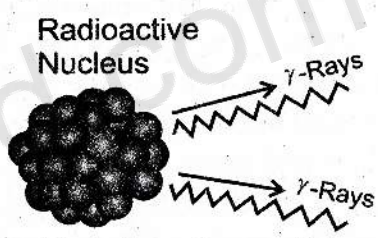


Emission of β-particle from the Nucleus

2. β rays produce ionization in air, but this ionization is nearly 1/100 times less than that is produced by α rays.
   Although the speed of β rays is very high, since their mass is very small, hence, their energy is less as compared to α rays.
3. β rays affect photographic plates but the effect produced by β rays is much higher than that produced by α particles.
4. They produced fluorescence in Barium Platinocynide.
5. They can pass through a thick layer of matter. For example they can easily pass through one centimeter thick sheet of aluminium.
6. β rays are affected by electric and magnetic fields.
7. β rays carry negative charge. The mass and charge of β rays is equal to the mass and charge of an electron. So we can say that β rays are electrons which are emitted by the nucleus.

Gamma (γ) rays:

1. They move with the speed of light.
2. The ionization produced in a gas by them, is very small as compared to α or β rays.
3. γ rays affect photographic plates but this effect is much higher than that of β rays.
4. γ rays also produce fluorescence in Barium Platinocynide.
5. The penetrating power of γ rays is much higher than the β rays and they can easily pass through 30 cm thick sheet of iron.
6. They are not affected by electric and magnetic fields.
7. γ rays are such electromagnetic waves which are emitted by the nucleus.



Emission of γ-particle from the Nucleus

Q. What do you mean by half life? Explain.

Ans. Half life:

We have already studied that radioactive elements continuously emit radiations, due to which they change into new elements. For example if an α particle is emitted by an element ${}^{A}_{Z}X$ then

$${}^{A}_{Z}X - {}^{4}_{2}\alpha \rightarrow {}^{A-4}_{Z-2}Y$$

${}^{A-4}_{Z-2}Y$ is a new element. Similarly, If β-particle is emitted by an element, then

$${}^{A}_{Z}X - {}^{0}_{-1}\beta \rightarrow {}^{A}_{Z+1}Y$$

It is changed to ${}^{A}_{Z+1}Y$. The atomic mass number of the newly produced element remains the same, but its charge number increases by one unit. It is due to the fact that protons and neutrons are present inside the nucleus, which continuously change into one another. When a neutron emits a β-particle, it changes into a proton. So the charge of the new element is greater by one unit.

In such a reaction, **the original element is called the parent element and the newly formed element is called the daughter element**. The number of breaking atoms is proportional to the number of atoms left in that element. This means that the number of initially breaking atoms is large, which decreases with time.

An indefinite time is required for completing the breaking process of atoms in radioactive elements.

Definition:

The half life of an element is that time during which the number of atoms of that element are reduced to one half.

For example, if the half life of a radioactive elements is T, then at the end of this time the number of atoms in this element remains one half, after a time 2T, the number of atoms remains 25% and after time 3T, the number of atoms are reduced to 12.5% of the initial number.

Q. What are stable and unstable nuclides? Write down the uses of radio isotopes in our daily life.

Ans. **Stable Nuclides:**

Nuclei which do not emit radiations naturally are called stable nuclei. Most of the nuclei whose atomic numbers is from 1 to 82 are stable nuclei. The stable elements can be changed into unstable form by bombarding them with neutrons. Such elements are called radio isotopes.

Unstable Nuclides:

The elements whose atomic number is greater than 82, are naturally unstable. These elements emit different types of radiations all the time and continuously change from one type of element to another.

Radio Isotopes:

The stable elements which are changed into unstable elements by bombarding them with neutrons, are called radio isotopes. Radio isotopes are being used in different fields of our life for different purposes.

Use of Radio Isotopes:

1. Use in Agriculture:

Unhealthy seeds are exposed to radioactive radiations. By doing this, seeds get much resistance to the ailments of crops. By using such seeds, higher yield is achieved.

2. Use in Medicine:

Radio isotopes are being used to diagnose the internal disease of body and curing different diseases without surgery. For example, iodine-131 is used for the study of thyroid glands while phosphorus 32 is used to diagnose the brain tumor.

The parts suffering from cancer absorb more quantity of isotopes and in this way indicate the correct position of the diseased part which helps in the treatment. Radioactive Cobalt-60 is used for curing cancerous tumors and cells.

Q. What is Einstein's Mass Energy Equation?

Ans. Einstein's Mass Energy Equation:

There exists a relationship between different forms of energy in accordance with the law of conservation of energy. But no relationship was established between energy and mass.

In 1905, Einstein gave his theory of relativity, it also contain the idea that the energy and matter are interchangeable. For this change an equation was given, known as Einstein's mass-energy equation.

$$E = mc^2$$

Which means that if mass m of matter is converted into energy, then this will be equal to E, where as C is the speed of light. Its value is $3 \times 10^8\ ms^{-1}$

Q. What is meant by fission chain reaction. How can it be controlled?

Ans. Nuclear Fission:

Nuclear fission can be defined as, **breaking of a nucleus into two parts with the release of large amount of energy.**

In 1938, Ottohann and Strassmann bombard slow neutrons on uranium. As the neutron is a neutral particle, it was expected that uranium nucleus will absorb it and becomes heavy uranium nucleus. But it didn't happen and nucleus of uranium broke into two nearly equal parts with the release of two or three neutrons and large amount of energy. Following equation shows this experiment.

$$^{235}_{92}U + {}^{1}_{0}n \rightarrow {}^{141}_{56}Ba + {}^{92}_{36}Kr + 3\,{}^{1}_{0}n + \text{Energy}$$

In this equation Ba and Kr denotes Barium and Krypton respectively.

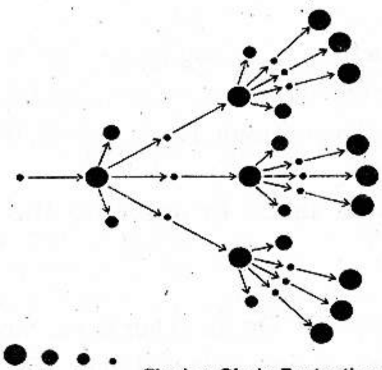
When a fission reaction takes place, the sum of masses of the produced nuclei and that of neutrons, is less than the total mass of original nucleus. This difference of mass results in the release of energy according to Einstein's mass energy equation.

Fission Chain Reaction:

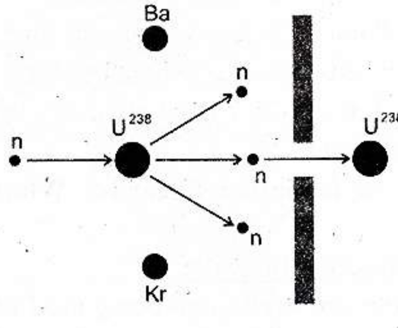
When a neutron reacts with a uranium nucleus, two or three neutrons are released then every one of these neutrons will react with uranium nucleus and more neutrons will be released. And in this way, fission goes on increasing. Such type of reaction is known as fission chain reaction.

The energy liberated during the fission reaction is in the form of heat. As in the chain reaction, fission continues and in this way energy goes on increasing. Fission reaction becomes uncontrollable and whole of the matter explodes causing a huge destruction. Such a reaction is used in atomic bomb.

If fission reaction is controlled, then this energy produced as a result of the reaction, is used for useful manner. **A system in which the fission reaction is controlled is called a controlled fission reaction.** In this process the surplus neutrons are absorbed by Boron or cadmium rods. This is done in nuclear reactor.



U Ba Kr n Fission Chain Protection

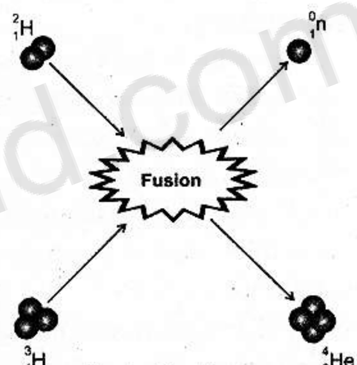


Controlled Fission Reaction

Q. What do you know about fusion reaction? Explain.

Ans. **Fusion Reaction:**

A reaction in which two smaller nuclei fuse to from a heavy nucleus with the release of energy is called nuclear fusion reaction.



Fusion Reaction

It was observed that the total mass of a nucleus is always less than the total mass of nucleons. for example. If we determine the mass of a Helium nucleus, it should be equal to the total mass of two neutrons and two protons. But when the mass of nucleus was determined. It was less than the mass of nucleons. This difference of mass was explained by Einstein's mass energy equation.

If an atom of deuterium is fused with an atom of Tritium than a Helium nucleus or α particle is formed. Following equation explains this reaction.

$$^2_1H + ^3_1H \rightarrow ^4_2He + ^1_0n + \text{energy}$$

The amount of energy released by a fusion reaction is much greater than that released by a fission reaction. In fusion reaction, isotopes of hydrogen form Helium nucleus nearly 17.6MeV of energy is liberated. But it is very difficult to produce a fusion reaction. Work has to be done against the electrostatic force which requires greater amount of energy for fusion reaction. The required temperature is obtained by exploding fusion bomb. i.e. an atomic bomb inside a hydrogen bomb. Efforts are being made to achieve energy through fusion reaction for peaceful purposes. If the scientists succeed in controlling the fusion reaction, then we will be able to get an infinite store of energy without radiation hazards.

Source of Solar Energy:

It is considered that the energy coming from the sun and stars is due to fusion reaction for producing α-particles i.e., the hydrogen is converted into Helium because the temperature inside the Sun is very high. The temperature at the centre of Sun is nearly 20 million Kelvin, whereas at its surface it is 5 million Kelvin. Due to high temperature in the sun, the hydrogen is converted into Helium.

Bethe Concept about fusion reaction

The Scientist, Bethe suggested that a fusion reaction is taking place inside the Sun. According to this reaction, when 4 hydrogen nuclei fuse together, two positrons and three α rays are produced nearly 25.7 Mev of energy is also released. This reaction is responsible for the solar and sateller energy.

Q. What are radiation hazards? What steps must be taken to minimize the radiation dangers?

Ans. **Radiation Hazards:**

Radiations are useful and being used for different purposes. On the other hand, there exists a danger of radiation hazards. It is a problem that radiations are invisible and their adverse effects also do not appear at once. Their excessive use destroys the healthy tissues, due to ionization property of radiation. Although this property is used to destroys the cancerous cell, but the use of radiation in a greater quantity, destroy the healthy tissues as well, due to which, there is always a risk of cancer or some other incurable diseases.

Precautions:

(i) One should not stay near its source, because radiations spread in all directions.

(ii) For treatment doctor should use the radiations for minimum possible time.

(iii) After diagnosing the proper part of the body, it should be exposed to radiation carefully by calculated amount.

(iv) The nuclear waste must be buried in the deserts far away from the colonies, or in the sea.

(v) A thick wall of concrete should be built around the nuclear reactor in order to protect from its radiations.

(vi) The radioactive material must be placed in a lead box.

(vii) To find the quantity and intensity of radiations, film badge and dosimeter must be used. It also helps us to find whether the quantity of radiation has not exceeded the required amount.

(viii)The persons working in the laboratories, where radioactive material is available should get themselves medically checked regularly.

EXAMPLES

Example 18.1:

The half-life of krypton is 3.16 minutes. Out of 100g of krypton, how much will be left after 9.48 minutes?

Solution:

Total quantity of krypton = 100 g

Half life of krypton = T = 3.16 minutes

Number of half lives $= \dfrac{9.48}{3.16} = 3T$

The remaining quantity of krypton after first half life, $T = \dfrac{100}{2} = 50$ g

The remaining quantity of krypton after second half life, $2T = \dfrac{50}{2} = 25$ g

The remaining quantity of krypton after third half life, $3T = \frac{25}{2} = 12.5\ g$

Example 18.2:

Find the energy produced from 20kg of carbon if it is completely changed into energy.

(L. B '10)

Solution:

The given data is

Mass = m = 20 kg

Speed of light = $c = 3 \times 10^8\ ms^{-1}$

Formula:

$E = m\,c^2$

Putting values, we get

$E = (20)\,(3 \times 10^8)^2$

$= 20 \times 9 \times 10^{16}$

$= 180 \times 10^{16}$

$E = 1.8 \times 10^{18}\ J$

NUMERICAL PROBLEMS

18.1: The Half life of radium is 1600 years. How much of 120g of radium will be left after 4800 years. **(L. B '10)**

Solution:

The given data is

Half life = 1600 years

Given mass of radium = 120 g

Time = 4800 years

Number of periods of half life $= \frac{4800}{1600} = 3\ T$

Mass of radium after first half life $= T = \frac{120}{2} = 60g$

Mass of radium left after 2nd half life $= 2T = \frac{60}{2} = 30g$

Mass of radium left after 3rd half life $= 3T = \frac{30}{2} = 15g$

18.2: Half life of Uranium 4.47 x 10^9 years. In how much time only 10 g will be left out of 40g?

Solution:

The given data is

Half life = $T = 4.47 \times 10^9$ years

Time = t = ?

Mass of uranium left = 10 g

Initial mass of uranium = 40g

Mass before one half life time is $= 10 \times 2 = 20g$

Before two half life time is = 20 x 2 = 40g

This shows that total time passed is equal to 2T.

Hence

Total time passed = t = 2T.

$= 2 \times 4.47 \times 10^9$ years

$= 9.94 \times 10^9$ years

18.3: Find the mass of a body from which 1.35×10^{15} J of energy is obtained?

Solution:

The given data is

Energy = E = 1.3×10^{15} J

Mass = m = ?

Speed of light = c = 3×10^8 ms^{-1}

Formula:

$E = mc^2$

Putting values, we get

$1.35 \times 10^{15} = m \times (3 \times 10^8)^2$

$1.35 \times 10^{15} = m \times 9 \times 10^{16}$

$$\frac{1.35 \times 10^{15}}{9 \times 10^{16}} = m$$

$\boxed{0.015 \text{ kg} = m}$

$\boxed{m = 15 \text{ g}}$

MULTIPLE CHOICE QUESTIONS

Q. CIRCLE THE CORRECT ANSWER.

1. Nucleus consists of:

a) protons and positron
b) protons and neutrons
c) electrons and neutrons
d) protons, electrons, neutrons

2. Mass of proton is:

a) 1.67×10^{-31} kg
b) 1.67×10^{-27} kg
c) 2.67×10^{-31} kg
d) 0.67×10^{-31} kg

3. Mass of a neutron is:

a) $1,67 \times 10^{-31}$ k1g
b) 1.67×10^{-27} kg
c) 2.67×10^{-31} kg
d) 0.67×10^{-31} kg

4. Nucleons are the particles:

a) protons and electron
b) electron and neutron
c) protons, electrons and neutrons
d) proton and neutron

5. A nucleon is heavier than an electrons nearly

a) 1932 times b) 1836 times
c) 1732 times d) 1632 times

6. Mass of an atom is equal to sum of the masses of:

a) protons and neutrons
b) protons and electrons
c) protons, electrons, neutrons
d) electrons and neutrons

7. The whole mass of an atom is concentrated in the:
a) orbits b) nucleus
c) electrons d) protons

8. Radioactivity was discovered by:
a) Simon Ohm
b) Ottohann & Strassman
c) Henry Becquerel
d) Rutherford

9. In connection with X-rays Henry Becquerel made experiments with:
a) radium b) thorium
c) polonium d) uranium

10. How many types of radiations were emitted from radioactive source when experiment was performed by Rutherford?
a) two b) three
c) four d) seven

11. Which radioactive rays are affected by the magnetic field?
a) alpha rays b) beta rays
c) gamma rays
d) alpha and beta rays

12. α-rays passing through a gas produce:
a) excitation b) ionization
c) evaporation d) condensation

13. The range for α-rays emitted by thorium is:
a) 2.7 cm b) 8.62 cm
c) 30 cm d) 50 cm

14. The mass of α-particles is to that of hydrogen atoms:
a) two times b) three times
c) four times d) equal

15. The speed of β-rays ranges with respect to speed of light:
a) 1 to 50% b) 50 to 100%
c) 1 to 99% d) 70 to 100%

16. The ionizing power of β-rays is less than that of α-rays by:
a) four times b) $\frac{1}{10}$ times
c) 25 times d) $\frac{1}{100}$ times

17. β-rays can pass through an aluminum sheet which is thick by:
a) 1 mm b) 2 mm
c) 2.7 cm d) 30 cm

18. Gamma-rays can easily pass through a sheet of iron which is thick by:
a) 1 cm b) 2.7 cm
c) 8.2 cm d) 30 cm

19. For the completion of the breaking process of atoms in radioactive elements, the time required is:
a) some days b) some weak
c) 24 hours d) infinite

20. The half life is the time during which the number of atoms in a radioactive element becomes:
a) 25% b) 50%
c) 75% d) 100%

21. The stable elements can be changed into unstable form by bombarding them with:
a) positrons b) protons
c) neutrons d) electrons

22. Iodine 131 is used for the study of:
a) adrenal glands
b) thyroid glands
c) pituitary glands
d) pancreas

23. Phosphorous 32 is used to diagnose the:
a) Liver disease b) diabetes
c) brain tumor d) AIDS

24. Radioactive cobalt 60 is used for curing:
a) cancerous cells
b) AIDS
c) poliomyelitis
d) T.B

25. The equation E = mc^2 was given by the scientist
a) Bohr b) Ottohann
c) Einstein d) Ohm

26. Breaking of a nucleus into two parts with the release of large amount of energy is called:
a) Nuclear Fission
b) Nuclear Fusion
c) Radioactivity d) Ionization

27. In nuclear reactors, the surplus neutrons are absorbed by:
a) sodium rods b) Cadmium rods
c) Carbon-Rods d) Cesium Rods

28. The process by which lighter nuclei fuse together to form a heavy nucleus is known as:
a) Nuclear fission
b) nuclear fusion
c) radioactivity d) electron activity

29. When an atom of deuterium is fused with an atom of tritium, then a nucleus will be formed named.
a) Kr-nucleus b) Xe-nucleus
c) Na-nucleus d) He-Nucleus

30. The amount of energy liberated by the fusion of one atom of deutrium and one atom of tritium to form a Helium nucleus is
a) 25.7 Mev b) 17.6 Mev
c) 2.5 Mev d) 49.8 Mev

31. Temperature at the center of the sun is nearly
a) 5 million Kelvin
b) 10million Kelvin
c) 15 million Kelvin
d) 20 million Kelvin

32. Theory of relativity was presented in
a) 1904 b) 1905
c) 1906 d) 1907

33. Temperature at the surface of the sun is
a) 5 million Kelvin
b) 15 million Kevin
c) 25 million Kelvin
d) 35 million Kevin

34. When 4 hydrogen nuclei fuse together to form a helium nucleus, then the energy liberated is
a) 17,6 Mev b) 2.5 Mev
c) 5.5 Mev d) 25.7 Mev

35. The radioactive material must be placed in a box of
a) carbon b) lead
c) silicon d) selenium

36. The scientist who suggested the chain reaction taking place inside the sun is
a) Newton b) Einstein
c) Strassman d) Bethe

37. Energy released in the fusion reaction as compared to the fission reaction is
a) more b) less
c) same d) None

38. The instrument used to find the intensity of radiations is:
a) capacitor b) electroscope
c) Ammeter d) Dosimeter

39. By which property of radiation the cells of the human body are destroyed:
a) Excitation b) Ionization
c) Evaporation d) penetration

40. The particle which is not affected by electric and magnetic field is called:
a) α particles b) β - particles
c) γ – particles d) all of these

41. Beta particles are actually:
(Group-II/2007)
a) Protons b) electrons
c) Neutrons d) Positrons

42. Nuclear fission reaction was discovered in:
a) 1936 b) 1937
c) 1938 d) 1939

43. A particle with mass equal to mass of the electron but opposite and equal charge of electron is:
a) Proton b) Neutron
c) Positron d) All

44. Penetrating power of rays is very high. (Group-I/2007)
a) alpha b) beta
c) gamma d) X-rays

45. Alpha particle contains
(Group-I/2006 and Group-II)
a) two neutrons b) two protons
c) two neutrons and two protons
d) none of these

46. Number of protons present in a nucleus is called: *(L. B 2004)*
a) atomic weight b) mass
c) charge number d) α-particles

47. The sodium nuclei is a stable nuclei because it's atomic number is 82:
(L. B '10)
a) Quite greater than
b) Greater than
c) Equal to
d) Less then

48. Measuring unit of nuclear radiation is:
(a) ms^{-1} (b) kmh^{-1}
(c) rem (d) all of these

49. Safety limit of radiation used is
(a) 6 rem per year (b) 7 rem per year
(c) 8 rem per year (d) 5 rem per year

ANSWERS

1.	b	2.	b	3.	b	4.	d	5.	b	6.	a	7.	b
8.	c	9.	d	10.	b	11.	d	12.	b	13.	b	14.	c
15.	c	16.	d	17.	a	18.	d	19.	d	20.	b	21.	c
22.	b	23.	c	24.	a	25.	c	26.	a	27.	b	28.	b
29.	d	30.	b	31.	d	32.	b	33.	a	34.	d	35.	b
36.	d	37.	a	38.	d	39.	b	40.	c	41.	b	42.	c
43.	c	44.	c	45.	c	46.	c	47.	d	48.	c	49.	d

SHORT ANSWERS

1. How many parts an atom has?

Ans. An atom consists of two parts one is inner part called nucleus consisting of nucleons and other is outer orbit consisting of electrons.

2. How much a nucleon is heavier than an electron?

Ans. A nucleon is 1836 times heavier than an electron.

3. What is an atomic number? (L. B '08)

Ans. The number of proton in the nucleus of an atom is called atomic number and it is represented by Z, it is also called charge number.

4. What is an atomic mass number?

Ans. The total number of protons and neutrons in nucleus of an atom is known as atomic mass number and is represented by A.

5. What is a nuclide?

Ans. The symbolic representation of an element with atomic number and mass number is called a nuclide e.g. ${}^{1}_{1}H$, ${}^{2}_{1}H$, ${}^{3}_{1}H$ are nuclides.

6. What are isotopes?

Ans. The atoms of an element whose atomic numbers are the same but their atomic mass numbers are different are called isotopes e.g. deuterium is an isotope of hydrogen.

7. What is natural radioactivity? (L. B '10)

Ans. A process in which the elements with the charge number greater than 82, naturally keep on radiating, is called natural radioactivity.

8. What is a radioactive isotope?

Ans. The atoms of radioactive elements whose atomic numbers are same but mass numbers are different, are called radioactive isotopes.

9. What happened when magnetic field is applied to the rays coming from a radioactive source in Rutherford's experiment?

Ans. When magnetic field is applied to the radiations emitted from a radioactive source, they are bended in three different directions. These radiations are divided into three types of rays which are alpha, beta and gamma rays.

10. What type of radiation has more power of ionizations?

Ans. Alpha rays have greater power of ionization due to heavy mass and charge.

11. What type of radiation has more power of penetration?

Ans. Gamma rays have greater power of penetration as compared to that of α and β-rays.

12. What is meant by half life? Explain. (L. B '10)

Ans. The half life of an element is that time during which the number of atoms of that element are reduced to one half.

13. What are stable nuclides?

Ans. Nuclei which don't emit radiations naturally are called stable nuclei. Most of the nuclei whose atomic number are from 1 to 82 are stable nuclei.

14. What are unstable nuclei?

Ans. Nuclei which keep on radiating naturally and converted to other nuclei are called unstable nuclei. The elements having atomic number greater than 82 are unstable nuclei.

15. How can stable nuclei be converted into unstable nuclei?

Ans. Stable nuclei can be converted into unstable nuclei by bombarding them with neutrons.

16. What are radio-isotopes?

Ans. Stable nuclei which are converted into unstable nuclei by bombarding with neutrons, are called radio-isotopes.

17. Are the mass and energy interchangeable?

Ans. Yes mass and energy are inter-convertible. It can be observed from the Einstein's mass energy equation, which shows that mass and energy are inter-convertible according to the equation $E = mc^2$.

18. What is nuclear fission?

Ans. Breaking of a nucleus into two parts with the release of large amount of energy is called fission reaction.

19. What is nuclear fusion?

Ans. A reaction in which two smaller nuclei diffuse together to form a heavy nucleus with the release of energy is called nuclear fusion.

20. Why fission reaction is called chain reaction?

Ans. When a neutron reacts with uranium nucleus, two or three neutrons are released, then every one of these neutron will react with uranium nucleus and more neutrons will be released. And in this way, fission goes on increasing. That is why, it is called fission chain reaction.

21. What is positron?

Ans. Positron is a particle with mass equal to the mass of electron having opposite and equal charge.

22. What are artificial sources of radiations?

Ans: Source of nuclear rays are natural as well as man made natural sources are radon gas radioactive elements while T.V waves nuclear power plants are man made sources.

23. What is measuring unit of nuclear radiation?

Ans: Measuring unit of nuclear radiation is rem.